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The American Species Referred to Thinnfeldia

By Edward W. Berry

The genus *Thinnfeldia* was established by Ettingshausen in 1852 * to include certain fern-like remains from the European Jurassic, which from their resemblance to the living species of *Phyllocladus* he referred to the Coniferae. Considerable diversity of opinion has since existed as to their true affinity. Thus Schenk considers them members of the Cycadales, while F. Braun refers them to the Filicales, where they are admitted by both Schimper and Saporta, and formerly by Nathorst, though latterly he regards them as Conifers. Potonie (Natürlichen Pflanzenfamilien, 1900) includes the genus among the Filicales of the tribe Pecopterides, but he evidently does not include the American or Arctic species which have been referred to this genus.

In 1874 Oswald Heer described a species from the Cretaceous of Spitzbergen as *Thinnfeldia arctica* (incorrectly spelled *Thinfeldia* by him). Turning to this country we find Lesquereux in 1868 describing a species from the Dakota group as *Phyllocladus subintegrifolius*. Subsequently Heer described apparently identical remains, which were found in considerable abundance in the Atane beds of Greenland, transferring them to the genus *Thinnfeldia* and renaming the species *Thinnfeldia Lesquereuxiana*, classing it under the heading "Incertae sedis" directly following the ferns.

In 1889 Fontaine described three species of *Thinnfeldia* from the Potomac formation of Virginia, including them among the ferns, where they are undoubtedly rightly placed. Additional species from various American localities have been noted or characterized by Newberry, Hollick, Fontaine and Knowlton. It is obvious from the foregoing that the genus is a rather indefinite one not well understood and badly in need of revision, which task I have attempted for the American species. I have not included the European species because of lack of material. Judging from those I have seen figured and from Lesquereux's remarks on others,* I should say that they are correctly classed among the Filicales.

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* Ettings. Abhandl. k. k. Geol. Reichsanstalt, 1^3: no. 3, 2. 1852.

The American species which have been referred to this genus embrace two distinct types of plants. Those from the older Cretaceous beds of Potomac age and from the Triassic apparently represent true ferns comparable with the European type, and since the genus as properly restricted is an old one, not appearing elsewhere after the close of the Jurassic (except for the doubtful *Thinnfeldia variabilis* Velen.) the American Cretaceous species of Fontaine may be regarded as the dwindling remnants of an older flora (only one of his species is at all common or occurs outside of Virginia), thus forming one of the many surviving elements in the Potomac flora that gave it such a decidedly Rhaetic facies. It is quite otherwise with the middle and upper Cretaceous species which have been referred to the same genus. They are all much larger-leaved plants and some of them have a wide distribution. The remains in themselves are unmistakably characteristic, although their true botanical affinity is perhaps not so plain; superficially there is considerable resemblance to the polymorphous filicalean genus *Sagenopteris* from the older Mesozoic of this country and Europe, but this resemblance is only superficial.

Each describer has doubtingly referred his specimens to *Thinnfeldia* as a matter of convenience or precedent rather than from any conviction of relationship with the species from the older formations, and all have noted their resemblance to the existing species of *Phyllocladus*. I have made careful comparisons with the living material available at the New York Botanical Garden and am thoroughly convinced that all of the mid- and late Cretaceous species should be included in the coniferous family Taxaceae. They may perhaps form a link between the Podocarpeae and the Taxeae, and while they are unmistakably related to *Phyllocladus* their extremely large size compared with the existing members of that genus and other minor differences such as petiolate forms and the general absence of crenate margins make it desirable to refer them to a new genus which while indicating their proper relationship shall keep them distinct from the existing small-leaved species. This genus may be designated *Protophyllocladus*, and such additional remarks as may be necessary may well be made in considering the respective species.

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*Fl. Dak. Group, 34.

Protophyllocladus gen. nov.

Comparatively large leaves, of coriaceous texture; linear to ovate-lanceolate in outline; with entire, somewhat undulate, or slightly crenate margins: mostly broader toward the apex: with straight narrowly wedge-shaped base: slightly petiolate: midrib usually stout below, often becoming obliterated toward the apex: secondaries fine, numerous, parallel, occasionally forked, usually buried in the parenchyma of the leaf; they leave the midrib at an acute angle and run directly to the margins.

Constituting well characterized remains ranging from the middle Cretaceous to the basal Tertiary.

Protophyllocladus subintegrifolius (Lesq.)

Phyllocladus subintegrifolius Lesq. Am. Jour. Sci. **46**: 92. 1868; Cret. Flora, 54. *pl. 1. f. 12.* 1874; Fl. Dak. Group, 34. *pl. 2. f. 1–3.* 1892.

Thinnfeldia Lesquereuxiana Heer, Fl. Foss. Arct. 6^2: 37. *pl. 44. f. 9, 10; pl. 46. f. 1–12 a, 12 b.* 1882; Newb. Fl. Amboy Clays, 59. *pl. 11. f. 1–17.* 1896; Hollick, Trans. N. Y. Acad. Sci. **11**: 99. *pl. 3. f. 6.* 1892; Bull. Geol. Soc. Am. **7**: 12–14. 1895; Ann. N. Y. Acad. Sci. **11**: 58. *pl. 3. f. 4, 5.* 1898; **11**: 419. *pl. 36. f. 6.*

Thinnfeldia subintegrifolia Knowlton, Bull. U. S. Geol. Surv. **152**: 228. 1898; Hollick, Bull. N. Y. Bot. Gard. **2**: 403. *pl. 41. f. 13, 14.* 1898.

This is a most wide-spread species, ranging in considerable abundance from Greenland to New Jersey and west to Kansas and Nebraska, in beds of approximately the same age, quite the opposite from what would occur if it represented a waning type.

Originally referred to *Phyllocladus* by Lesquereux, his type figure (*f. 12. pl. 1*, Cret. Flora) is identical in outline with certain leaves of the living *Phyllocladus asplenifolia* Hook. f. (*P. rhomboidalis* Rich.) in which, however, the larger leaves are crenate, while those most like the fossil are somewhat smaller. The resemblance is also markedly close to an undescribed *Phyllocladus* (No. 6282, herb. N. Y. Bot. Gard.) from the Lake Brunner district of the South Island, New Zealand. In this form the leaves are very variable, ranging from nearly simple to almost pinnately parted, some with but the slightest indication of the pronounced crenations of others.

Subsequently discovered remains from Kansas are considerably larger than Lesquereux's type specimen, as are also a number of the Greenland specimens. Some of the Raritan forms have a somewhat different aspect, being long and narrow; sometimes the margins are entire, oftener they are undulate or toothed. Newberry, who examined some hundreds of leaves, so abundant are they in the Raritan clays, says "the aspect which they present is not quite that of any known ferns" and he places them among "Coniferae of Uncertain Affinities." Were the linear form and toothed margins constant features these leaves might be considered specifically distinct, but the specimens show every gradation to forms undistinguishable from those of this species from other localities. *Pl. 11, f. 16,* Fl. Amboy Clays is very similar in all respects to *Podocarpus Nageia* R. Br. from the existing flora of Japan, but there is no resemblance to any other species of *Podocarpus* that I have seen.

An additional locality that may be noted for this species is in the Matawan formation near Cliffwood, N. J.

All these leaves have the aspect of *Phyllocladus*, easily seen but scarcely definable, and except for their large size are strictly comparable, the leaves of *Phyllocladus* showing the same variability of outline as do the fossil leaves.

Protophyllocladus lanceolatus (Knowlton)

Thinnfeldia lanceolata Knowlton, Bull. U. S. Geol. Surv. **105**: 49. *pl. 5. f. 5.* 1893.

This species, which occurs in Montana in beds of Laramie age, is related to the preceding, but is larger, with pointed apex, and according to Knowlton, with entire margin, although his very perfect figure shows slight and wide crenations. He considers it to be closely allied to the existing genus *Podocarpus*, pointing out its resemblance to *Podocarpus macrophylla* Don, a southeastern Asiatic species, *Podocarpus Rumphii* Bl. and *Podocarpus leptostachya* Bl., East Indian and Malayan species, and *Podocarpus salicifolia* Kl. & Karst., a tropical American species. Specimens of the latter, which seems to be the most similar to the fossil leaf, from St. Kitts and Central America are somewhat smaller, although specimens from the north coast of South America average larger and exactly resemble the fossil leaf in size and outline. They differ, however, as do most of the Podocarpeae, in their very entire margins, their indistinct vertical secondaries and the form of their midrib, which in all species of *Podocarpus* which I have seen, except *Podocarpus Nageia* R. Br. from Japan, is thick and prominently marked to the tip of the leaf, while in the fossil leaf the midrib is obliterated by its dichotomous branching some distance below the apex and the secondaries branch at an acute angle and do not parallel the midrib.

Protophyllocladus polymorphus (Lesq.)

Salisburia polymorpha Lesq. Am. Jour. Sci. II, **27**: 362. 1859 (nom. nudum); Ann. Rep. U. S. Geol. & Geog. Surv. Terr. **1872**: 404. 1873; Tert. Fl. 84. *pl. 6. f. 40, 41.* 1878.

Thinnfeldia polymorpha Knowlton, Proc. Biol. Soc. Wash. **7**: 153. 1892; Bull. U. S. Geol. Surv. **105**: 47. *pl. 5.* [*1*]. *f. 1–4.* 1893. (Not *T. polymorpha* Ettingshausen, 1860.)

Thinnfeldia montana Knowlton, Bull. U. S. Geol. Surv. **152**: 227. 1898; Bull. U. S. Geol. Surv. **163**: 11. *pl. 1. f. 1–3.* 1900.

Fragmentary remains from Nanaimo, Vancouver Island, were named *Salisburia polymorpha* by Lesquereux and were subsequently described and figured for a final report which was never published. He afterward described under the same name specimens from Montana, although not positive of their identity with the Vancouver specimens. Whatever may be the final disposition of the Nanaimo forms, those from Montana are certainly not referable to *Salisburia* (*Ginkgo*), although evidently Coniferous. Lesquereux's type figures (Tertiary Flora, *pl. 60. f. 40, 41*), greatly resemble in both form and venation certain leaves of existing species of *Phyllocladus*, for instance *Phyllocladus asplenifolia* Hook. f., although they are somewhat larger, and the remains referred to this species by Knowlton are still larger and petiolate. This species is closely allied to the two preceding and according to Knowlton is positively related to *Phyllocladus*. It occurs in beds of Montana,* Laramie, and Livingston age.

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* Belly River series, on the Missouri River seven miles below Coal Banks, Montana, in strata which are at least in part synchronous with the Montana formation.

THINNFELDIA Ettings. Abhandl. k. k. Geol. Reichsanstalt, 1^3: No. 3, 2. 1852 (restricted)

Fontaine * gives the following diagnosis, which is very nearly that of Schimper: "Fronds bipinnate or tripinnate; pinnules varying much in size and shape, mostly oblong, ovate-lanceolate or oblong-lanceolate, decurrent and mostly confluent at the base; coriaceous; primary nerve of the pinnules dissolved before attaining the apex into many dichotomous nerves; secondary nerves going off at a very acute angle, diverging in ascending, several times dichotomous." Filical remains from the older Mesozoic.

Thinnfeldia Fontainei nom. nov.

Thinnfeldia variabilis Font. Potomac Flora, 110. *pl. 17. f. 3–7; pl. 18. f. 1–6.* 1889; Font. in Stanton, Bull. U. S. Geol. Surv. **133**: 15. 1895.

Fontaine's name is antedated by *Thinnfeldia variabilis* Velen. (Gymnosp. Böhm. Kreidef. 6. *pl. 2. f. 1–5; pl. 3. f. 12.* 1885), an altogether different species as pointed out by Hollick. It is fitting that the new name should commemorate the original describer.

This is the most common fern near Brooke, Virginia, and reappears in the Knoxville beds of Tehama County, California, the only species of *Thinnfeldia* at all common in the Potomac or reappearing at any other locality. It is unnecessary to redescribe this species; no one has ever doubted that it is a fern. Though specifically different it closely resembles *Thinnfeldia rhomboidalis* Ett.

THINNFELDIA GRANULATA Font. Potomac Flora, 111. *pl. 26. f. 10–12; pl. 27. f. 1–5, 8; pl. 169. f. 1.* 1889

A rare fern found only near Dutch Gap Canal and near Potomac Run, Virginia, in the Potomac formation. Resembles *Mariopteris muricata* (Schloth.) Zeiller.

THINNFELDIA ROTUNDILOBA Font. Potomac Flora, 111. *pl. 27. f. 6, 7.* 1889

This fern is still rarer than the preceding; it is recorded from Fredericksburg and near Potomac Run, Virginia, in Potomac strata. Resembles *Sphenopteridium dissectum* (Göpp.) Schimper.

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* Potomac Flora, 110. 1889.

† Bull. N. Y. Bot. Gard. **2**: 404. 1902.

THINNFELDIA? RETICULATA Font. in Ward, Older Mesozoic Fl. U. S., Ann. Rep. U. S. Geol. Surv. **20**^{2}: 235. *pl. 22. f. 1, 2.* 1900

Poor remains make this determination only provisional. It is undoubtedly a fern, however, possibly a new genus. The veins are strong and anastomose exactly as in *Thinnfeldia variabilis* Velen. Occurs in the Triassic near York Haven, Pennsylvania.

THINNFELDIA ARCTICA Heer (incorrectly spelled *Thinfeldia*), Fl. Foss. Arct. **3**: 123. *pl. 35. f. 11–16; pl. 36. f. 10b.* 1874

From the Cretaceous of Spitzbergen (Cape Staratschin); included here because of its resemblance to the upper pinnae of *Thinnfeldia Fontainei*, from which it differs only in the pinnules being more rounded at the apex.

THINNFELDIA VARIABILIS Velen. Gymnosp. Böhm. Kreidef. 6. *pl. 2. f. 1–5; pl. 3. f. 12.* 1885; Hollick, Bull. N. Y. Bot. Gard. **2**: 403. *pl. 41. f. 12.* 1902

This species is listed by Velenovsky under "Species Incertae Sedis." While it may not be a fern the venation is not that of a coniferous plant, and it may best be left in this genus provisionally; although in so doing the genus is brought down to the mid-Cretaceous, which is undesirable as this species has nothing in common with the other species and is undoubtedly generically distinct. Hollick's remains from the Cretaceous of Chappaquidick Island, Mass., are indistinguishable from the type.

PHYLLOCLADOPSIS Font. Potomac Flora, 204. 1889

For the sake of completeness in the enumeration of American Phyllocladian remains I append a short notice of the following species.

PHYLLOCLADOPSIS HETEROPHYLLA Font. Potomac Flora, 204. *pl. 84. f. 5; pl. 167. f. 4.* 1889

The thick texture and immersed venation are those of *Phyllocladus*, but the outline and margin are different; the general aspect is decidedly not that of a fern. But for the diverging veins to the margin this species would fall in *Nageiopsis* Font., which is such a striking type in the Potomac flora, with fourteen species, so like the existing *Nageia* section of *Podocarpus*, that Fontaine hesitates in classing them as generically distinct. It curiously illustrates the mixed affinities of these ancient members of the Taxaceae.

The genus *Podocarpus* is abundantly preserved in European strata, Schimper (Pal. Végét.) enumerating nine species; *Phyllocladus* on the other hand has not yet been found, although Heer* describes some curious remains from the Cretaceous of Spitzbergen under the name of *Phyllocladites rotundifolius.*

PASSAIC, N. J.

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* Heer, Fl. Foss. Arct. 3: 124. *pl. 35. f. 17–21.* 1874.